CUSTOMIZED VIDEO PROCESSING MODES FOR HD-CAPABLE SET-TOP DECODERS

FIELD OF THE INVENTION

[0001] The present invention is directed generally to methods and apparatuses for processing video signals at user premises, and more particularly to a method and apparatus for processing a video signal at a user premises, in which the video signal originates at a broadcast location.

BACKGROUND

[0002] The transition from NTSC standard definition to ASTC high definition broadcasting means that consumers are no longer watching only 4:3 aspect ration programs. With the transition to widescreen high definition broadcasts, programs can be broadcast in 4:3 or 16:9 aspect ratios. Of those broadcast in 16:9 high definition formats, the actual video may not fill the entire 16:9 screen. There will be black bars to the left and right of the image. These black bars can cause fading issues with televisions and can be annoying to viewers.

[0003] The present invention is therefore directed to the problem of developing a method and apparatus for controlling presentation of video images to limit the use of black bars on television screens when an image is being displayed on a screen for which the image is not optimal.

SUMMARY OF THE INVENTION

[0004] The present invention solves these and other problems by providing *inter alia* a method and apparatus for controlling a display of video being output from a set-top box.

[0005] According to one aspect of the present invention, an exemplary embodiment of a method for controlling an image being output from a set-top box determines if a user selected channel contains programming having a first aspect ratio and stretches automatically video from the user selected channel having the first aspect ratio, if the user selected channel contains programming having the first aspect ratio, to fill a frame having a second aspect ratio that is different than the first aspect ratio using a predetermined stretching function. This determining and stretching is initiated automatically upon tuning to a user-selected channel.

[0006] According to another aspect of the present invention, an exemplary embodiment of a method for controlling video output from a set-top box, upon receiving a zoom toggle command from a user via a remote control unit, the method determines if a user-selected program includes a second aspect ratio different than a first aspect ratio and ignores the zoom toggle command if the programming does not include the second aspect ratio. If the programming does include the second aspect ratio, then the method selects a next available zoom mode for a first or second aspect ratio television type if the television type setting is set for the first or second aspect ratio, respectively, and sets an output format to a mode specified by a first predetermined output setting.

[0007] According to still another aspect of the present invention, an exemplary embodiment of an apparatus for controlling a video image output from a set-top box includes a processor and a memory. The memory is coupled to the processor and stores

encoded, computer readable instructions that cause the processor to control an image being output to a display by: determining if a user selected channel contains programming having a first aspect ratio; and stretching automatically video from the user selected channel having the first aspect ratio, if the user selected channel contains programming having the first aspect ratio, to fill a frame having a second aspect ratio that is different than the first aspect ratio using a predetermined stretching function.

[0008] According to yet another aspect of the present invention, an exemplary embodiment of an apparatus for controlling video includes a remote control unit, a receiver, a processor and a graphical user interface. The receiver interacts with the remote control unit to receive a zoom toggle command from a user via said remote control unit. The processor determines if a user-selected program includes a second aspect ratio different than a first aspect ratio and ignores the zoom toggle command if the programming does not include the second aspect ratio. The graphical user interface enables a user can to enter a television type setting via a user settings screen. The processor determines the television type setting from the user settings screen and selects a next available zoom mode for a first or second aspect ratio television type if the television type setting is set for the first or second aspect ratio, respectively, and sets an output format to a mode specified by a first predetermined output setting.

[0009] Other aspects of the present invention will be apparent to those reviewing the following drawings in light of the specification.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG 1 depicts a screen image having a widescreen 16:9 aspect ratio.

[0011] FIG 2 depicts the screen image of FIG 1 in a standard 4:3 aspect ratio.

[0012] FIG 3 depicts the screen image of FIG 1 in a hybrid 14:9 aspect ratio.

[0013] FIG 4 depicts a letterbox display of a widescreen image on a standard screen HDTV.

[0014] FIG 5 depicts a full screen display of a widescreen image on a standard screen HDTV.

[0015] FIG 6 depicts pillarbox display of a standard screen image on a widescreen HDTV.

[0016] FIG 7 depicts an example of screen fade on a widescreen HDTV.

[0017] FIG 8 depicts a linear stretch display of a standard screen image on a widescreen HDTV.

[0018] FIG 9 depicts a zoom display of a standard screen image on a widescreen HDTV.

[0019] FIG 10 depicts DTV output formats and corresponding aspect ratios.

[0020] FIG 11 the common 15:9, 14:9 and 4:3 hybrid aspect ratio broadcasts.

[0021] FIG 12 depicts representative images used to illustrate the ASTB 16:9 zoom Modes according to one aspect of the present invention.

[0022] FIGs 13-15 depict the representative images from FIG 12 for the various zoom Modes for 16:9 aspect ratios according to another aspect of the present invention.

[0023] FIGs 16-18 depict the representative images from FIG 12 for the various zoom Modes for 4:3 aspect ratios according to another aspect of the present invention.

[0024] FIG 19 depicts an exemplary embodiment of a method for controlling a display of an image from video being output by a set top box according to still another aspect of the present invention.

[0025] FIG 20 depicts an exemplary embodiment of a method for controlling a display of an image from video being output by a set top box according to yet another aspect of the present invention.

[0026] FIG 21 depicts an exemplary embodiment of an apparatus for controlling a display of an image from video being output by a set top box according to still another aspect of the present invention.

[0027] FIG 22 depicts an exemplary embodiment of a method for controlling a display of an image from video being output by a set top box according to yet another aspect of the present invention.

DETAILED DESCRIPTION

[0028] It is worthy to note that any reference herein to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearances of the phrase "in one embodiment" in various places in the specification are not necessarily all referring to the same embodiment.

Introduction

[0029] The exemplary embodiments of the present invention relate to video

processing features for digital set-top boxes (*e.g.*, the DCT-5100 High-Definition digital cable set-top box) and television receivers. During the transition to all-digital television broadcasts, there remains considerable confusion regarding the various resolutions, aspect ratios, and scan formats inherent in the new ATSC Digital Television (DTV) standard. The consumer electronics industry remains without agreement on the optimal manner to process the large number of video broadcast formats that are now in use. Presented with more viewing choices than ever before, in terms of what programming is available for viewing and in what format programming may be viewed, consumers will remain faced with a significant learning curve to become comfortable with digital television. In response to this confusion, the exemplary embodiments herein include features for a digital set-top box that provide for greater viewing flexibility for a wide variety of consumers who own a wide variety of HDTV sets.

[0030] The embodiments herein are also applicable to any set-top boxes or receivers that include high definition decoding capabilities.

ATSC Video Formats

[0031] The ATSC has defined 18 Digital television (DTV) formats that include High Definition, Enhanced Definition, and Standard Definition resolutions. The formats represent a combination of picture resolutions, aspect ratios, and scan modes. The 18 ATSC DTV formats are presented in Table 1 with the most commonly-used formats shaded in gray.

Table 1

	Vertical Pixels	Horizontal Pixels	Pixel Shape	Aspect Ratio	Scan Mode	Frame Rate (frames/second)
HD	1080	1920	Square	16:9	Progressive	24
	1080	1920	Square	16:9	Progressive	30
	1080	1920	Square	16:9	Interlaced	30
	720	1280	Square	16:9	Progressive	24
	720	1280	Square	16:9	Progressive	30
	720	1280	Square	16:9	Progressive	60
ED	480	704	Rectangular	16:9	Progressive	24
	480	704	Rectangular	16:9	Progressive	30
	480	704	Rectangular	16:9	Progressive	60
	480	704	Rectangular	4:3	Progressive	24
	480	704	Rectangular	4:3	Progressive	30
	480	704	Rectangular	4:3	Progressive	60
	480	640	Square	4:3	Progressive	24
	480	640	Square	4:3	Progressive	30
	480	640	Square	4:3	Progressive	60
SD	480	704	Rectangular	16:9	Interlaced	30
	480	704	Rectangular	4:3	Interlaced	30
	480	640	Square	4:3	Interlaced	30

[0032] Each format has a clearly defined vertical resolution, horizontal resolution, pixel shape, aspect ratio, scan mode and associated frame rate.

Picture Resolution

[0033] The resolution of an ATSC DTV image is measured in horizontal and vertical pixels. A pixel is a tiny piece of the overall image. The greater the number of pixels, the more detail and sharpness an image will have. The original NTSC analog television format measured resolution in terms of the number of vertical lines, but in an effort to begin merging televisions and computer monitors under a single standard, the ATSC has opted to define video resolution in pixels. The HD video formats have a vertical resolution or either 720 pixels or 1080 pixels. The ED and SD video formats have a vertical resolution of 480 pixels.

Pixel Shape

[0034] Early models of analog televisions used pixels that were rectangular in shape that were taller than they were wide. This was mostly due to the way that cathode ray tubes were able to draw images on the screen and not necessarily an intentional characteristic. When computer monitors were developed, cathode ray tube technology was further advanced and they were able to generate pixels that were square in shape. In an effort to bring designs for televisions and computer monitors closer together, the ATSC has defined some DTV formats that specifically use square pixels (such as the HD video formats). DTV-capable televisions must be able to draw both square and rectangular pixels on their screens, which allows them to display both television and computer video images.

Aspect Ratio

[0035] Aspect ratio is the measure of an image's width to its height and is generally expressed as (**w:h**). The original NTSC analog television standard specified a single aspect ratio that was 4:3. Since there was only one aspect ratio available, television manufacturers built their sets to have display screens that matched the 4:3 images. As a result, the overwhelming majority of television sets and television programs have the 4:3 aspect ratio. As a result, the 4:3 aspect ratio is often referred to as the "standard screen" or "full screen" format.

[0036] The ATSC DTV formats can have one of two possible aspect ratios – either 4:3 or 16:9. Since the ATSC was primarily concerned with reinventing the way that people watch television, and to further increase the visual improvements of the new HD

formats, the ATSC opted to institute the 16:9 (as referred to as "widescreen") aspect ratio for the new HD formats. Images with 16:9 aspect ratios are typically more impressive and attractive to the human eye since the field of vision of a human eye is much more broad than it is high. Widescreen images tend to fill more of our field of vision and create a more panoramic viewing experience, which is why most motion pictures are filmed in widescreen formats. A side-by-side comparison of widescreen and standard screen aspect ratios is presented below in FIG 1 and FIG 2.

[0037] To further complicate issues, broadcasters have adopted several "hybrid" aspect ratios to help bridge the gap and ease the transition from the NTSC 4:3 standard to the eventual ATSC 16:9 standard. These hybrid aspect ratio programs are actually broadcast in a 16:9 format, however, the video within the 16:9 frame does not fill the entire frame. One very popular hybrid aspect ratio format is the 14:9 format, since it is the mathematical "halfway point" between a 4:3 standard screen image and a 16:9 widescreen image. Since the active video does not fill the entire widescreen frame, the broadcaster embeds black sidebars, also known as curtains, at the edges of the frame to fill the 16:9 aspect ratio. The 14:9 format is depicted in FIG 3. Notice that in comparison to the images shown in FIGs 1-2, the hybrid aspect ratio is wider than a standard screen image but narrower than a true widescreen image.

Scan Mode

[0038] There are two ways to draw video images on a television or monitor screen. The first method, the older of the two, is referred to as the interlaced scan mode. In the interlaced scan mode, the image is drawn in two separate passes. In the first pass, all of

the odd "lines" of the image are drawn from left to right and from top to bottom. In the second pass, all of the even "lines" of the image are drawn from left to right and from top to bottom. Each pass results in a portion of the image known as a field. Two fields combined together create a frame, which is the entire image. All analog televisions drawn images on the screen in this fashion.

[0039] Computer monitors were able to take advantage of advancements in CRT technology and in addition to using square pixels also adopted the progressive scan modes. In the progressive scan mode, every line of the image is drawn in a single pass, from left to right and from top to bottom. The frame is drawn all at once without dividing it into two separate fields as is done in the interlaced scan mode. This results in much less flicker in the video and smoother motion across the screen. Once again, in an effort to bring televisions and computer monitors closer together, the ATSC has created a number of DTV formats that take advantage of the progressive scan mode. Since motion pictures are filmed and viewed in what is essentially a progressive scan format, the ATSC wanted to capture the "movie theater effect" in some of the DTV formats as well. For backwards compatibility, several DTV formats still use the older interlaced scan mode.

Frame Rate

[0040] As discussed above, the interlaced and progressive scan modes use different methods to draw a complete picture frame on the screen. Interlaced scan methods draw a complete field every 60^{th} of a second, and since two fields are used to create a complete frame, the frame rate is equal to 30 frames per second (fps). The most common progressive scan rate is 60 fps, meaning that the complete image is drawn once ever 60^{th}

of a second. However, the ATSC has also defined additional progressive scan frame rates within the DTV standard. Most notable among these frame rates is the presence of 24 fps. This happens to be the frame rate at which motion pictures are filmed and presented in movie theaters. The film is projected onto the theater screen at a rate that equals 24 complete picture frames every second. In an effort to provide DTV modes that capture the "movie theater effect" the ATSC defined several formats that use 24 fps progressive scan modes.

Aspect Ratio Mismatches

[0041] With the adoption of the ATSC DTV formats which include both 16:9 and 4:3 aspect ratios, and the introduction of widescreen televisions to augment the existing population of standard screen televisions, it becomes readily apparent that viewing situations will arise when the tuned video program has an aspect ratio that is different from that of the television's display screen. The consumer electronics industry has developed techniques for handling these aspect ratio mismatches. These techniques include:

- Letterbox displays
- Pillarbox displays
- Stretch displays
- Zoom displays

[0042] Televisions and set-top decoders apply these techniques in very specific

scenarios that rely greatly on the DTV format of the tuned video program. As a result, the formats in Table 1 will be referred to constantly throughout this section, particularly the most common DTV formats which appear in the table shaded in gray.

Letterbox Displays

[0043] Letterbox displays are not new to the general viewing public. While some viewers may dislike the letterbox display format, almost everyone has seen it at one time or another. The letterbox technique is used to display images on a television screen when the image itself has an aspect ratio that is wider than the display screen. The image is scaled down in size (and resolution) until its width fits the physical width of the display screen. As a result, the image cannot fill the physical height of the display screen. In order to "frame" the picture on the screen and reduce any visual distraction, the portions of the screen above and below the image that are not filled with active video are usually set to black. The letterbox technique is depicted in FIG 4, where the widescreen image from FIG 1 is shown being displayed on a 4:3 standard screen television.

[0044] The letterbox technique allows the viewer to see the entire video image as it was originally filmed without any portions of the picture being cropped and discarded in order to fill the entire screen. Whenever a video that was originally filmed in a widescreen format is reformatted to fill a 4:3 standard screen television, portions of the image must be cropped from each video frame. The full screen version of the widescreen image as presented on the same 4:3 television is presented below in FIG 5.

[0045] A quick comparison of the television displays shown in FIGs 4 and 5 reveals

that the letterbox technique effectively maintains the original aspect ratio of the video program, but at the expense of lower picture resolution and black static areas on the television screen. The full screen display does in fact fill the entire screen and takes advantage of the full vertical resolution of the television, but significant portions of the original video program must be cropped and cannot be enjoyed by the viewer. While some viewers wish to view widescreen programs in their original aspect ratios regardless of any loss in resolution or the presence of static black bars, other viewers insist that they have a full screen picture at all times even if it means they are not able to view the entire image as originally filmed.

[0046] Referring to Table 1, it is clear that all HD formats are defined to have an aspect ratio of 16:9. As a result, all 4:3 standard screen HDTVs will show HD programming in the letterbox format as seen in FIG 4. There is no other way for a 4:3 television to show a widescreen image on its display screen. Whenever the television is fed with either 1080i or 720p video signals, the display will automatically switch to the letterbox format with static bars above and below the active video. Given this information, it is easy to ask why do television manufacturers even offer HDTVs that have 4:3 display screens. The reason is fairly simple: the vast majority of television programming available today is still in a 4:3 format, and these programs will fill the entire screen of a 4:3 HDTV (as seen in FIG 5) which is the expected behavior by some viewers. However, all HD programming will have to be viewed in the letterbox format on these sets.

Pillarbox Displays

[0047] The pillarbox display, unlike the letterbox display, is relatively new to the viewing public since the adoption of the ATSC DTV standard. Whereas the letterbox display is used to fit widescreen programming on a 4:3 screen (though programs that are wider than 16:9 will also be shown as letterbox on a widescreen TV), the pillarbox format is used to fit 4:3 programming on a widescreen display. Since a 4:3 image is too narrow to fill the width of a widescreen television, the television typically will center the image on the screen and place dark bars to the left and right of the image. A typical pillarbox display on a widescreen HDTV is depicted below in FIG 6. The image is centered and scaled vertically to fit the physical height of the display screen, and the portions of the screen that are not filled with active video are usually set to black.

[0048] The pillarbox technique is one method used to display standard screen 4:3 images on a widescreen display. Television manufacturers who make widescreen HDTVs already know that the vast majority of television programming is still in the 4:3 aspect ratio. Therefore, the manufacturers have designed their widescreen televisions to work with standard screen images in a number of ways. The only method to display 4:3 content in its original aspect ratio without any distortion or video cropping on a widescreen HDTV is to apply the pillarbox format.

Stretch Displays

[0049] Widescreen television manufacturers took into consideration the fact that 90-95% of the content available on television today is 4:3. HDTVs use a number of different display technologies, including cathode ray tubes (CRTs), liquid crystals, plasma cells,

and digital light processing. Some of these display technologies are susceptible to phenomena known as "screen burn" and "screen fade." This typically occurs in phosphor-based display technologies such as CRTs and plasma cells. Referring to FIG 6, and keeping in mind that 90-95% of the television content today is still 4:3, it becomes clear that the left and right sidebars will be present a great deal of the time. The center portion of the television screen is constantly exercised and illuminated (and as such slowly fades in brilliance and clarity over time) but the sidebars remain unexercised and in a like-new state. This is known as screen fade. When a widescreen image is finally displayed on the HDTV, the portion of the picture in the areas where the black sidebars usually reside will be noticeably brighter and crisper than the center area of the screen. A depiction of screen fade on a widescreen HDTV that has been primarily used to watch 4:3 video in the pillarbox format is shown below in FIG 7.

[0050] Most widescreen HDTV manufacturers recommend (particularly on expensive plasma displays and any CRT-based display) that the pillarbox format be used for less than 20% of total viewing. Since 90% or more of the content available today is in 4:3 format, widescreen HDTVs have been designed with several ways of "fitting" 4:3 video to their 16:9 screens. These methods include the stretch display, which will be discussed here, and the zoom display, which will be discussed in the next section.

[0051] Most widescreen HDTVs have implemented one or more types of stretch modes. These modes allow the viewer to fill the 16:9 screen with active video so that no static black bars reside on the display. The reason for this is twofold: the potential for screen fade is greatly reduced when the pillarbox display mode is used less frequently, and some viewers actually prefer to always have video fill their entire television screen

regardless of any distortion or cropping that takes place. In discussing any kind of stretch mode on a widescreen HDTV, the industry understanding is that the stretch only takes place in the horizontal direction and that there is no processing that takes place in the vertical direction. Zoom modes, which are discussed in the next section, apply horizontal and vertical processing to fit the video to the display screen. In general, stretch modes imply processing along the horizontal width of the screen only.

[0052] There are a number of ways to perform a horizontal stretch of an image on a widescreen display. Television manufacturers use the quality of their stretch and zoom modes as key differentiators in the marketplace. While the complexity of the stretch algorithms varies greatly between HDTV models, fundamentally stretch modes are implemented using linear processing or nonlinear processing.

- Linear stretch – Horizontal distortion is uniform across the entire image
- Nonlinear stretch – Horizontal distortion is focused on the edges of the image

[0053] An example of a linear stretch mode is depicted below in FIG 8. In this example, the 4:3 content that is shown in FIG 6 is linearly stretched by the widescreen HDTV to fill the entire display.

[0054] A comparison of FIGs 6 and 8 shows some of the horizontal distortion that occurs when a linear stretch mode is invoked by the HDTV. The white house in the center of the picture is much wider than it would appear if viewed in person (or in the pillarbox format which preserves the proper aspect ratio). For inanimate objects, such as the house in this picture, the distortion that is introduced by the HDTV does not look that odd to the human eye. However, scenes that contain human beings (and particularly human faces) can look very strange to the human eye when viewed in a stretch mode,

since we have fairly fixed notions of what a "normal" human being or human face looks like. When stretched to fill a widescreen HDTV, humans on-screen can look very distorted and can immediately cause the reaction that there is excessive distortion in the picture, even more than if the exact same stretch method is applied to a scene containing inanimate objects such as in FIG 8.

Zoom Displays

[0055] In addition to the stretch modes (linear and nonlinear) that widescreen television manufacturers have implemented on their products, an alternate display mode known as a "zoom display" has started to appear with increasing frequency on many widescreen HDTV sets. The zoom mode is basically a two-dimensional stretch. The image is stretched horizontally to fill the width of the display screen, but is also stretched vertically so that the amount of horizontal distortion is greatly reduced. However, once-viewable portions of the picture at the top and bottom are in effect "zoomed" off the screen and are basically cropped.

[0056] The zoom display is an alternative to the basic stretch display that some viewers may not enjoy because of the horizontal distortion that is introduced, particularly when viewing people in this manner. The zoom display stretches the picture in both directions, though depending on the manufacturer, the amount of stretch in both directions may be very similar or very different. An example of a zoom mode (where equal amounts of stretch are applied horizontally and vertically) is shown below in FIG 9.

[0057] To see the difference between the zoom display and the stretch display,

compare the television displays in FIGs 8 and 9. There are several noticeable differences between the two images. To illustrate these differences, compare the white house in the center of the picture, the street sign on the left of the picture, and the concrete post at the lower left of the picture. In the zoom display, the house and the sign have no appearance of horizontal distortion and appear in the normal (original) aspect ratio. This appears to be an advantage over the linear stretch display. However, it can also be seen that the chimney of the white house is much closer to the top of the display screen and a sizable portion of the concrete post has disappeared from the display screen entirely. Portions of the top and bottom of the original image are therefore cropped from view and cannot be seen by the viewer. While in this scene the effect of losing the upper and lower portions of the screen is negligible, scenes that focus on "close-ups" on dialogue and such may crop signification portions of the actors' faces and heads from view. Some viewers may find that to be visually disruptive and may prefer to watch those scenes in a stretch display or a pillarbox display. The choice is left to the viewer to decide what they believe "looks best" and the widescreen HDTV manufacturers have attempted to provide a number of options to suit the various preferences of the viewers.

ASTB Video Output Formats

[0058] The Advanced Set-top Boxes (ASTBs) are equipped with a number of video outputs. These outputs include component video ports, an s-video port, a composite video port, and an RF output. Since the component video ports are intended to be the primary connection used with an HDTV, and the majority of the proposed video features

deal with DTV formats (which the component video ports alone can accommodate), the embodiments herein will focus on the component video (YPbPr) outputs.

[0059] An exemplary embodiment of a set top box, such as the DCT-5100, is capable of generating video outputs in any one of five different ATSC DTV formats. These formats are shown in Table 1 shaded in gray and are referred to as 1080i, 720p, 480p (16:9), 480p (4:3), and 480i. The numeric portion of the video format refers to the number of vertical pixels, the "p" refers to the progressive scan mode, and the "i" refers to the interlaced scan mode. Each of these formats has a single defined aspect ratio except for the 480p format. The aspect ratio restrictions are depicted FIG 10.

[0060] FIG 10 depicts the aspect ratios that are defined for each of the five DTV output formats included in the exemplary embodiment of an ASTB. Therefore, it is impossible for this embodiment to generate a 1080i 4:3 picture, for example. Since these five DTV formats are the only formats available on the component video outputs of the DCT-5100, any proposed video features will essentially boil down to a generated video output in one of these five formats. It is essential to understand how different HDTVs (widescreen and standard screen) display each of these five DTV formats in order to understand the resultant output that will be generated by each proposed video feature. For example, many widescreen HDTVs automatically stretch 480p signals to fill the display screen, regardless of whether the video source signal has a 4:3 480p format or a 16:9 480p format. The reason that the televisions do this is fairly straightforward: 480p is the output format generated by all progressive scan DVD players, and the TV manufacturer assumes that if the consumer has purchased a widescreen television, the consumer must also be watching widescreen (anamorphic) DVDs with their progressive

scan DVD player. As a result, the television stretches the 480p signal to fill the screen, which is the proper choice when viewing anamorphic DVDs on a progressive scan DVD player. However, this "auto-stretch" by the widescreen TV may produce a very different effect from the one desired from the exemplary embodiment.

Current ASTB User Settings

[0061] The exemplary embodiment of the ATSB provides to the consumer a "User Settings" screen that allows the consumer to configure the ASTB to work with their specific model of HDTV and set some general viewing preferences. An exemplary embodiment of an ASTB configuration menu is shown below in Table 2. The default values for each option as defined in the ASTB firmware are shown first (16:9, 1080i, 480i) and the additional values that can be selected are shown in parentheses.

Table 2

USER SETTINGS	
TV TYPE	16:9 (4:3 LETTERBOX, 4:3 PAN-SCAN)
YPbPr OUTPUT	1080i (720p, 480p, 480i)
4:3 OVERRIDE	480i (480p, OFF)
CLOSED CAPTION	DISABLED
OPTIONS:	
PEN SIZE	AUTO
FONT STYLE	AUTO
FOREGROUND COLOR	AUTO
FOREGROUND OPACITY	AUTO
BACKGROUND COLOR	AUTO
BACKGROUND OPACITY	AUTO
SERVICE SELECTION	AUTO
SETTINGS	AUTO
RESTORE DEFAULTS	

[0062] The three options used primarily for configuring the ASTB are known as **TV**

Type, YPbPr Output, and **4:3 Override**. These options allow the consumer to configure the exemplary embodiment of the ATSB to work with their particular model of HDTV and control the manner in which SD and HD content in viewed on the HDTV. The options perform the following functions:

- TV Type – Specifies the type of HDTV connected to the ASTB.
- YPrPb Output – Specifies the output video format on the set-top's component video ports except when the 4:3 Override is in effect.
- 4:3 Override – Specifies the output video format on the set-top's component video ports when the ASTB is tuned to a 4:3 program.

[0063] The 4:3 Override feature is one type of automatic output switching and addresses a number of issues such as postage stamped displays and screen burn/fade.

[0064] One of the advantages of the exemplary embodiment of the User Settings screen is that it has been designed with a "set and forget" approach, meaning that once the consumer finds the selections that work best with his/her particular model of HDTV, there is never a need to go back into the menu to change settings. As a result, the driving requirement for any addition that is to be made to the User Settings screen is that it **must be implemented** as a "*Set And Forget*" style option.

Video Features

[0065] The embodiments of the ATSB implement various stretch and zoom modes to provide more viewing options to the consumers and to counteract static black areas embedded in HD programs by some broadcasters.

ASTB 4:3 Stretch Mode

[0066] The exemplary embodiment of the ATSB incorporates some type of stretch mode for viewing true 4:3 programs on a 16:9 widescreen HDTV. This feature can be provided in addition to the standard 4:3 Override feature, and therefore can be implemented in such a fashion as to be complementary to the 4:3 Override feature. The ASTB Stretch Mode is **not** intended to be used with 4:3 content that is broadcast in a 16:9 format in the pillarbox mode.

Assumptions

[0067] The assumptions that were made in order to come up with the embodiments herein for implementation of the ASTB Stretch Mode are listed below.

- The Stretch Mode should apply to consumers with 16:9 HDTVs
- The Stretch Mode should not apply to consumers with 4:3 HDTVs
- The Stretch Mode should augment the 4:3 Override Feature
- The Stretch Mode should be invoked when the ASTB is tuned to 4:3 content
- The Stretch Mode should not be invoked when the ASTB is tuned to 16:9 content

[0088] On widescreen HDTVs, the stretch modes are used to fill the 16:9 screen with 4:3 video content. The stretch algorithms can vary, but the final result is a filled display screen. Standard television screens with 4:3 aspect ratios have no need for a stretch feature because the display screen matches the aspect ratio of 4:3 video content. Since the 4:3 Override feature is a standard feature on the ASTB product line, and any ASTB Stretch Mode would also deal with 4:3 video content, the Stretch Mode should be implemented in a complimentary fashion to the 4:3 Override.

Problems Addressed

[0089] The problem that this feature primarily addresses is any widescreen television that either does not have its own stretch mode for viewing 4:3 full screen, or a widescreen television that does a poor job of creating stretch displays. By incorporating this feature on the exemplary embodiments of ASTBs, the set-top boxes provide yet another viewing option that will enhance the feature set of the product and potentially improve the viewing experience of the consumer. Additionally, widescreen televisions that use phosphor-based display technologies are susceptible to screen burn & fade. The implementation of a stretch feature on the ASTB also serves to provide a safeguard against possible screen damage to a costly HDTV.

Exemplary Embodiment

[0090] The ASTB 4:3 Stretch Mode is not envisioned to be a frequently-toggled feature like the ASTB 16:9 Zoom Mode. It is envisioned that the consumer will use the ASTB Stretch Mode on a widescreen HDTV if either the widescreen HDTV itself does not supply a stretch mode or if the HDTV does a poor job with its stretch display. In that case, the consumer has the option of using the ASTB to perform the stretch instead.

[0091] Since most television manufacturers recommend viewing content that causes static black areas on the screen (such as pillarbox displays) less than 20% of the time to reduce any chance of screen fade, it is likely that the ASTB 4:3 Stretch Mode will not be toggled on and off frequently by the consumer. If the consumer decides to use the ASTB Stretch Mode, it will likely become the default mode for viewing 4:3 content on a 16:9 widescreen HDTV. If the consumer prefers the stretch modes offered by the HDTV, then

the standard ASTB 4:3 Override feature will be used to provide 4:3 video formats to the HDTV to stretch on its own.

[0092] Due to the likelihood that the ASTB Stretch Mode will be an "all or nothing" type of feature, meaning that the consumer will either use it the majority of the time or hardly at all, it is not critical that this feature be toggled from a remote control button. Though a remote control button provides a cleaner user experience to toggle the stretch feature on and off, as opposed to entering the User Setting screen and toggling the feature there, it is not deemed to be an absolute necessity in order to implement the ASTB Stretch Mode Feature.

[0093] The ASTB Stretch Mode can be added neatly and intuitively to the 4:3 Override menu selection in the User Settings screen. A "**STRETCH**" option can appear as an additional option next to 480i, 480p, and OFF. Since this feature is intended only for widescreen HDTVs, the **STRETCH** option under **4:3 OVERRIDE** can be made so that it is only accessible if the **TV TYPE** is set to 16:9. If the **TV TYPE** is set to 4:3 (either Letterbox or Pan Scan) then the ASTB Stretch Mode should not be accessible as it provides no advantage over the existing 4:3 Override feature.

[0094] The exemplary embodiments of the ATSB can be configured so that the primary output format, set via the **YPrPb OUTPUT** menu option, is one of the two available HD formats (720p or 1080i). In these cases, the **STRETCH** option should be available as one of the **4:3 OVERRIDE** settings. Additionally, the **STRETCH** option should be available if the **YPrPb OUTPUT** is set to 480p. Currently, if the **YPrPb OUTPUT** is set to 480i, the **4:3 OVERRIDE** automatically switches to OFF and becomes inaccessible. This same behavior should continue with the addition of the

ASTB Stretch Mode, since in this instance the consumer has forced the ASTB to output a known 4:3 video mode in 480i and there is no need for the stretch mode.

[0095] The addition of the **STRETCH** option to the **4:3 OVERRIDE** submenu is shown in Table 3. In the exemplary embodiment, the **STRETCH** feature is toggled from the User Settings screen and is enabled whenever the ASTB is tuned to true 4:3 content. In effect, the ASTB 4:3 Stretch Mode becomes an augmentation of the standard 4:3 Override feature that is easily turned off and on by the consumer by accessing the User Settings display.

Table 3 - Addition of the ASTB Stretch Mode to the User Settings Menu

USER SETTINGS	
TV TYPE	16:9 (4:3 TVs have no need to view 4:3 video stretched)
YPbPr OUTPUT	1080i, 720p, or 480p (480i defaults the 4:3 Override to OFF)
4:3 OVERRIDE	STRETCH (the consumer can still choose 480i, 480p, or OFF)

[0096] The ASTB 4:3 Stretch Mode can then be instantiated whenever the ASTB is tuned to a 4:3 service, regardless of whether it was an analog service or a digital service. The ASTB can recognize that it had been tuned to a 4:3 service, stretch the 4:3 video to fill a 16:9 viewing frame, and output the resultant widescreen video in the output format specified by the **YPbPr OUTPUT** setting in the User Settings screen. An exemplary embodiment of a logical process that would be invoked after a channel change is shown in FIG 19.

[0097] In step 101, a user-selected channel is tuned to.

[0098] In step 102, the determination is made if the service is a 4:3 service. If the

service is not a 4:3 service, in step 104 the **YPrPb OUTPUT** format is used and the process ends. If the service is a 4:3 service, the process moves to step 103, in which the override setting is determined.

[0099] If the override setting is not set to **STRETCH**, in step 105, the existing logic for the 4:3 Override feature is applied and the process ends. If the override setting is set to **STRETCH**, the process moves to step 106, in which the 4:3 video is stretched to fill a 16:9 frame. This stretching function can be a linear stretching function or a non-linear stretching function.

[00100] In step 107, any overlaying graphics (such as electronic programming guide information or closed-captioning text) is not stretched to avoid distortion.

[00101] In step 108, the video is converted to the output format specified by the **YPrPb OUTPUT** setting. For example, if the **YPrPb OUTPUT** setting is 1080i (determination made in step 109), the stretched video is 1080i (step 112). If the **YPrPb OUTPUT** setting is 720p (determination made in step 110), the stretched video is 720p (step 113). And, if the **YPrPb OUTPUT** setting is 480p (determination made in step 111), the stretched video is 480p (step 114).

[00102] In step 109, the stretched and converted video frames are output on the component video outputs. Only the primary High Definition video outputs (YPrPb) include stretched video frames. The secondary standard digital video outputs (*e.g.*, Composite, S-Vid, RF) include 4:3 video.

[00103] One embodiment of the ASTB Stretch Mode utilizes a linear stretch

algorithm, while others may utilize nonlinear stretch algorithms. Nonlinear stretch algorithms can reduce the perceived amount of distortion by the viewer and promote a more enjoyable viewing experience.

Advantages

[00104] There are some inherent advantages to this particular implementation of the ASTB Stretch Mode.

Advantages:

- The ASTB Stretch Mode fits very neatly into the "Set And Forget" theme of the User Settings menu as one of the selectable ways to watch 4:3 content.
- The ASTB Stretch Mode does not force a switch of the YPrPb output format, so there is no visible re-synch that must occur on the HDTV to reacquire and display the new format.
- The ASTB Stretch Mode can be augmented to include several different stretch algorithms if necessary (linear and nonlinear methods) that drop neatly into the User Setting
- The ASTB Stretch Mode would automatically protect expensive widescreen HDTVs from damage caused by screen burn and screen fade since it would be invoked as soon as the set-top tuned to known 4:3 content.

Drawbacks:

- The ASTB Stretch Mode cannot provide an "instant gratification" toggle for the consumer without a new remote control key.

[00105] Overall, it appears that the proposed implementation offers even more viewing options for consumers who own widescreen HDTVs and can help to reduce the chance of causing damage to any phosphor-based displays. Some consumers may decide that they do not like the way that the set-top performs the stretch based on their own personal viewing preferences, but since the ASTB 4:3 Stretch Mode is not a default setting and can be easily turned off, this is not an issue.

ASTB 16:9 Zoom Modes

[00106] The exemplary embodiments of the ATSB incorporate some type of zoom feature for viewing widescreen 16:9 broadcasts that have hybrid aspect ratio video. This feature would be provided in addition to the standard 4:3 Override feature, and therefore is implemented in such a fashion as to be complementary to the 4:3 Override feature. The ASTB Zoom Modes are intended to provide the consumer with several different options for viewing hybrid aspect ratio programming.

Assumptions

[00107] The assumptions that were made in order to come up with the proposed implementation of the ASTB 16:9 Zoom Modes are listed below.

- The Zoom Modes should apply to consumers with 16:9 HDTVs
- The Zoom Modes should apply to consumers with 4:3 HDTVs

- The Zoom Modes should complement the 4:3 Override Feature
- The Zoom Modes should be toggled via remote control
- The Zoom Modes should not be toggled via the User Settings menu
- The Zoom Modes should be selectable when the ASTB is tuned to 16:9 content
- The Zoom Modes should not be selectable when the ASTB is tuned to 4:3 content since this case is covered by the 4:3 Override and ASTB Stretch features

[0088] The ASTB Zoom Modes will be used primarily to fill the entire display screen on 16:9 HDTVs and as much of the display screen as possible on 4:3 HDTVs whenever the tuned HD programming contains static black areas embedded in the video. The vast majority of television content recorded over the last 5 decades has been in the standard screen 4:3 aspect ratio. There is not yet enough true widescreen 16:9 HD programming for a DTV broadcaster to fill an entire day, so often the older 4:3 content is upconverted to a DTV format and broadcast with black sidebars (known as the pillarbox display) to fill the required 16:9 video frame for an HD transmission.

Problems Addressed

[0089] The ASTB 16:9 Zoom Modes can offer viewers several different options when viewing HD broadcasts that do not have a full 16:9 frame worth of active video. The video is narrower than the 16:9 broadcast frame, and in order to comply with the 16:9 aspect ratio requirement specified by the ATSC DTV standard, static black bars are placed to the left and the right of the video to fill the width of the 16:9 frame (see FIG 5).

Static black bars that are embedded in the broadcast are typically of great concern to HDTV owners because until now there has been no way to counteract them. There are two reasons why a viewer would like to be able to counteract the embedded black bars in a widescreen broadcast: 1) they prefer to view "fullscreen" displays as often as possible and dislike any static black areas, or 2) the black areas can contribute over time to a phenomenon known as "screen burn" or "screen fade" which can damage an HDTV display, particularly the very costly plasma HDTVs.

Exemplary Embodiment

[0090] Since the ASTB Zoom Modes would in all likelihood be toggled by the viewer as he/she flips through the available channels to suit the program they have selected at that moment, a static menu setting such as the one used for the ASTB Stretch Mode would not be practical. This would force the viewer to enter the User Settings screen every time they tuned to a hybrid aspect ratio program which the viewer wished "to zoom" in some fashion. In order for the ASTB Zoom Modes to work intuitively and in a fashion consistent with the rest of the consumer electronics industry, the zoom modes must be toggled via the remote control.

[0091] In studying the most common hybrid aspect ratios used by DTV broadcasters today, the three used most often are the 15:9 hybrid, the 14:9 hybrid, and the 4:3 hybrid. In these cases, all of the video frames are in fact 16:9, yet the frames are filled with (centered) video that is either 15:9, 14:9, or 4:3. Since all three of these aspect ratios are narrower than 16:9, static black bars appear to the left and the right of the active video to center it within a 16:9 video frame. Examples of these three common hybrid aspect ratio

broadcasts are depicted in FIG 11. The static black areas to the left and right of the active video are actually part of the total video frame that is being transmitted by the broadcaster.

[0092] The ASTB 16:9 Zoom Modes should provide some benefit to consumers who own either a widescreen 16:9 HDTV or a standard screen 4:3 HDTV. Although the consumers who own the more expensive widescreen TVs which are more susceptible to screen burn and screen fade have more to gain from the implementation of the ASTB Zoom Modes, viewers with 4:3 HDTVs should also benefit from these zoom modes. However, since 16:9 HDTVs and 4:3 HDTVs display widescreen programming in very different fashions, the ASTB Zoom Modes should be implemented so that they behave differently for 16:9 HDTVs and 4:3 HDTVs.

ASTB 16:9 Zoom Modes on Widescreen HDTVs

[0093] Through the **TV TYPE** setting in the User Settings screen, the ASTB can determine that it is connected to either a 16:9 HDTV or a 4:3 HDTV. Using this information, the ASTB can tailor the ASTB Zoom Modes to what makes the most sense for the particular television connected to it. In the case of the widescreen HDTVs, the ASTB 16:9 Zoom Modes should be able to counteract the three commonly encountered hybrid display formats shown in FIG 11. Since the 15:9 and 14:9 hybrid formats are so similar to each other in terms of width, there is little need to have a zoom mode to support the 15:9 format and a separate mode to support the 14:9 format. A zoom mode to support the 14:9 format alone will also handle the 15:9 format as well, though there will be very slender strips of video cropped off the screen in the 15:9 hybrid scenario. The 15:9 and

14:9 formats are fairly close in width to the full 16:9 video frame. While the term "zoom" in the consumer electronics industry typically implies a two dimensional stretch of an image horizontally and vertically (to reduce distortion in any one direction), the 15:9/14:9 zoom mode would implement a "horizontal-only" stretch to fill the entire 16:9 frame with active video with very little horizontal distortion (as opposed to stretching a 4:3 image to fill a 16:9 frame).

[0094] The 4:3 hybrid aspect ratio is quite a bit narrower than the 15:9 and 14:9 hybrid formats and as a result should be handled by two different "zoom" formats. The first mode would perform a horizontal stretch of the 4:3 video to fill the 16:9 frame. The second mode would apply horizontal and vertical stretch to fill the width 16:9 video frame with little or no distortion, but there would be some cropping of the top and bottom of the original video image as it was stretched vertically to minimize horizontal distortion.

[0095] To summarize, exemplary embodiments of ASTB Zoom Modes for a widescreen 16:9 HDTV would include four selectable zoom modes that can be cycled through using the remote control and would "wrap" around to the top of the list with consecutive remote control button presses:

16:9 Zoom Mode #1: A "No Zoom" mode to remove all ASTB Zoom Mode processing to view the broadcast "as is."

16:9 Zoom Mode #2: A zoom mode that takes a centered 14:9 cutout of the 16:9 broadcast and horizontally stretches it to fill a 16:9 frame.

16:9 Zoom Mode #3: A zoom mode that takes a centered 4:3 cutout of the 16:9 broadcast and horizontally stretches it to fill a 16:9 frame.

16:9 Zoom Mode #4: A zoom mode that takes a centered 4:3 cutout of the 16:9 broadcast and horizontally and vertically stretches it to fill a 16:9 frame.

ASTB 16:9 Zoom Modes on Standard Screen HDTVs

[0096] Through the **TV TYPE** setting in the User Settings screen, the ASTB can determine that it is connected to either a 16:9 HDTV or a 4:3 HDTV. Using this information, the ASTB could tailor the ASTB Zoom Modes to what makes the most sense for the particular television connected to it. In the case of the 4:3 standard screen HDTVs, the ASTB Zoom Modes should be able to counteract the three commonly hybrid aspect ratios shown in FIG 11. However, 4:3 HDTVs are not designed to display 16:9 broadcasts as full screen images like the widescreen HDTVs are. As a result, every 4:3 HDTV available today must display 16:9 widescreen programming in the letterbox format (see FIG 4). Whenever a 4:3 HDTV is fed with a 1080i or 720p input signal, which it understands to use the 16:9 aspect ratio, it will automatically switch to a letterbox type of display. This is an important fact to keep in mind when discussing the ASTB Zoom Modes for a 4:3 HDTV.

[0097] Hybrid aspect ratio broadcasts will display as a "postage stamp" display on a 4:3 HDTV. Where a 16:9 widescreen TV would only display the black bars on the left and right of the active video, a 4:3 standard screen TV would display black bars on all

four sides of the active video. This occurs because the broadcaster has embedded black bars to the left and the right of the active video to fill a 16:9 video frame, and the 4:3 HDTV must use the letterbox display with black bars above and below the active video to fit the widescreen program to its standard screen display. This limits the effectiveness of the ASTB 16:9 Zoom Modes discussed for widescreen HDTVs previously because a 4:3 HDTV would always show black bars above and below the active video as a result of its own letterbox requirements. The zoom modes discussed for widescreen HDTVs would eliminate the postage stamp display on a 4:3 HDTV, but none of them could counteract the letterbox display.

[0098] In order to provide a degree of usefulness in the ASTB 16:9 Zoom Modes for owners of 4:3 HDTVs, an additional zoom mode that is only available for 4:3 HDTVs could be made available. It would provide the viewer with a fullscreen display, but at the cost of definition and panorama. Essentially, the final zoom mode designed for 4:3 HDTVs would force the ASTB output to a known 4:3 video format (either 480i or 480p) and display a centered 4:3 cutout of the 16:9 video frame on the screen. This would be the equivalent of a "cropped" display as opposed to a pan & scan display. The 4:3 cutout would be centered on the 16:9 video frame. Since the zoom modes are intended to counteract the hybrid aspect ratios with black areas to the left and right of the screen, the amount of active video that is actually being "cropped" in this case may be very little (for the 15:9 and 14:9 cases) or none at all (for the 4:3 case). This provides the 4:3 HDTV viewer with a level of functionality that is particularly useful for their television displays.

[0099] To summarize, an exemplary embodiment of ASTB Zoom Modes for a

widescreen 16:9 HDTV would include four zoom modes that can be cycled through using the remote control:

4:3 Zoom Mode #1: A "No Zoom" mode to remove all ASTB Zoom Mode processing to view the broadcast "as is."

4:3 Zoom Mode #2: A zoom mode that takes a centered 14:9 cutout of the 16:9 broadcast and horizontally stretches it to fill a 16:9 frame.

4:3 Zoom Mode #3: A zoom mode that takes a centered 4:3 cutout of the 16:9 broadcast and horizontally stretches it to fill a 16:9 frame.

4:3 Zoom Mode #4: A zoom mode that takes a centered 4:3 cutout of the 16:9 broadcast and converts the output format of the ASTB to a known 4:3 format (either 480i or 480p).

[0100] If the ASTB 4:3 Stretch Mode is implemented as well, then there is the possibility that the **4:3 OVERRIDE** could be set to **STRETCH** in certain cases. Since it has been proposed that the ASTB 16:9 Zoom Modes utilize the **4:3 OVERRIDE** setting in certain cases to decide what format output to generate to display on the HDTV, it is worthwhile to cover this scenario in a bit more detail. The ASTB 4:3 Stretch Mode is intended for use by consumers who own widescreen 16:9 HDTVs only. There is no need for a stretch feature for 4:3 standard screen HDTVs. As a result, the **4:3 OVERRIDE** option can only be set to **STRETCH** if the TV Type is 16:9. Likewise, the zoom modes tailored to a 4:3 HDTV are only invoked via the remote control if the **4:3 OVERRIDE** option is set to either 4:3 Letterbox or 4:3 Pan-Scan. In this case, the "STRETCH" option

is not accessible for the **4:3 OVERRIDE** menu and they only available options are **480i, 480p**, or **OFF**. The logical process covers the expected behavior for each of these three allowable settings.

Logical Process for the ASTB 16:9 Zoom Modes

[0101] The exemplary embodiment of the ASTB 16:9 Zoom Mode feature is a complex feature that provides a great amount of control to the viewer over how they wish to view 16:9 programming on their HDTV. The ASTB 16:9 Zoom Modes are envisioned primarily to allow the viewer to remove static black areas embedded in a 16:9 broadcast in order to provide a more pleasant viewing experience or to reduce the possibility of screen damage to a costly widescreen HDTV.

[0102] An exemplary embodiment 200 of a logical process for the ASTB 16:9 Zoom Mode feature as follows would be invoked via a remote control button press is shown in FIG 20.

[0103] In step 201 a zoom mode toggle command is received from the remote control, after which in step 202 a determination is made as to whether the currently tuned service is a 16:9 broadcast. If the service is not a 16:9 service, then the zoom toggle is ignored in step 205 and the process ends. If the service is a 16:9 service, then the zoom toggle is allowed and the process continues.

[0104] In step 203, the **TV TYPE** setting is determined from the User Settings screen entered via a graphical user interface.

[0105] If the **TV TYPE** is 16:9, in step 206, each toggle press moves to the next

mode available for that TV Type, and in step 207 the output format is set to the mode specified by the **YPrPb OUTPUT**. The process then ends

[0106] If the **TV TYPE** is 4:3 Letterbox or 4:3 Pan Scan, in step 208 each toggle press moves to the next mode available for that TV Type.

[0107] In step 209, the determination is made as to whether the fourth zoom mode is selected (*i.e.*, 4:3 Zoom Mode #4: A zoom mode that takes a centered 4:3 cutout of the 16:9 broadcast and converts the output format of the ASTB to a known 4:3 format (either 480i or 480p)). If not, in step 211 the output format is set to the mode specified by the **YPrPb OUTPUT** and the process ends. If so, the output format is set to the mode specified by the 4:3 override setting.

[0108] The **4:3 OVERRIDE** format provides a means for the ASTB 16:9 Zoom Mode feature to know what the user's preference is for viewing 4:3 video on their 4:3 HDTV. If the user has selected **480i**, then the 4th zoom mode for 4:3 HDTVs should output the cropped video in the 480i format. If the user has selected **480p**, then the 4th zoom mode for 4:3 HDTVs should output the cropped video in the 480p format. If the user has selected **OFF**, then the ASTB 16:9 Zoom Mode feature should toggle automatically to the 1st zoom mode for 4:3 HDTVs (which is the "no zoom" mode).

Graphical Representation of the ASTB 16:9 Zoom Modes

[0109] Since a picture is worth a thousand words, and it can be difficult to visualize the displays that will result on the HDTV screen as the user cycles through the zoom modes, several tables in the figures depict the resulting displays on the television screen

for each combination of HDTV type (widescreen or standard screen), hybrid aspect ratio broadcast formats, and ASTB Zoom mode.

[0110] FIG 12 contains three images that will be used to represent the three popular hybrid aspect ratio formats that are commonly used by broadcasters today. Each image represents a specific broadcast format. From left to right these images represent the 15:9 hybrid aspect ratio format, the 14:9 hybrid aspect ratio format, and the 4:3 hybrid aspect ratio format respectively. These images will be used in FIGs 13-18 to show that the set-top has tuned to a program that is being broadcast in one of these three hybrid formats.

[0111] FIGs 13-18 depict the displays that are produced on an HDTV screen when the user cycles through the various ASTB 16:9 Zoom Modes for each of the three popular hybrid aspect ratio formats shown above. FIGs 13-15 show the displays produced on a widescreen (16:9) HDTV. FIGs 16-18 show the displays produced on a standard screen (4:3) HDTV. Note that the tables do not show the displays for Zoom Mode #1, which is the "no zoom" mode and has no effect on the display that is produced on the HDTV screen, which is the version shown as the tuned program in each figure.

Advantages

[0112] There are some inherent advantages to this exemplary embodiment of the ASTB 16:9 Zoom Mode feature.

- The ASTB Zoom Mode feature is tailored to provide benefits to owners of both style of HDTV (16:9 and 4:3).
- The ASTB Zoom Mode feature can provide "instant gratification" with a remote control button press.

- The ASTB Zoom Mode feature can counteract static black bars embedded by broadcasters which could damage expensive widescreen HDTVs over time.
- The ASTB Zoom Mode feature offers several different modes to accommodate a range of viewer preferences.
- The ASTB Zoom Mode feature utilizes the options selected in the User Settings menu to enhance the logical process.

[0113] Overall, the exemplary embodiment offers even more viewing options for consumers who own widescreen and standard screen HDTVs and can help to reduce the chance of causing damage to any phosphor-based displays, particularly the expensive widescreen televisions. Consumers who own 4:3 HDTVs can fully eliminate the "postage stamp" display at any time with a couple of remote control button presses. Some consumers may decide that they do not like the way that the set-top applies the zoom processing based on their own personal viewing preferences, but since the ASTB Zoom Mode is not a default setting and can be easily toggled using the remote control, this is not an issue.

ASTB 4:3 Stretch Feature Support

[0114] The existing ASTB hardware (such as BCM 7035) is capable of supporting this feature on the primary video outputs (YPbPr or DVI) of the set-top box. The 7035 supports linear scaling factors, but linear and non-linear scaling factors can be used in other exemplary embodiments. The ASTB 4:3 Stretch feature may be augmented to take advantage of the non-linear scaling capabilities.

[0115] The video quality that will result on the secondary video outputs (s-video,

composite, and RF) can be affected when the stretch feature is in use. In one embodiment, the stretch processing is applied to the main video pipeline for presentation over the primary video outputs. In this case, the video for the secondary outputs needs to be "de-stretched" before presentation on the secondary video outputs.

ASTB 16:9 Zoom Feature Support

[0116] The existing ASTB hardware (BCM 7035) is capable of supporting this feature on the primary video outputs (YPbPr or DVI) of the set-top box. The 7035 supports linear scaling factors that may be applied horizontally and/or vertically to provide a simple "stretch" effect or a two-dimensional "zoom" effect. The exemplary embodiment takes a centered "cutout" of a 16:9 frame and applies the scaling factors to that cutout. Once that cutout has been made (either 14:9 or 4:3 depending on the zoom mode), then the application of the horizontal and/or vertical scaling factors is a relatively straightforward process.

[0117] The video quality that will result on the secondary video outputs (s-video, composite, and RF) may be affected when the stretch feature is in use. As in the above-mentioned embodiment, the zoom processing is applied to the main video pipeline for presentation over the primary video outputs. The video for the secondary outputs needs to be "de-zoomed" before presentation on the secondary video outputs. The secondary outputs would also need to show a different style of output than the primary video outputs due to the inherent video cropping that takes place in the zoom modes (for example, the primary outputs may present a zoomed 4:3 image whereas the secondary outputs may be expected to present a 4:3 letterboxed output).

[0118] FIG 21 depicts an exemplary embodiment 230 for implementing the above processes and methods. A set-top box 220 receives the incoming video from a cable or other source. A video processor 221 performs the above-mentioned processes based on programming stored in its memory 222. The converted video is output to a display 225. A remote control 226 activates the zoom toggle feature discussed above via a receiver 223 in the set-top box 220. A graphical user interface 224 interacts with the user to set the television type and other settings mentioned above.

[0119] In general, using the present invention a high definition capable set top receiver is informed of the aspect ratio of the TV it is connected to (4:3 or 16:9), and using this information the set top receiver manipulates the received video image using stretch/zoom techniques. The manipulated video image is then output to the display using one or more ATSC formats. The set top receive receives input from the user via front panel, RF, or IR remote control, for example, to select one or more zoom modes. The set top receiver will provide at least one customized zoom mode guaranteed to fill the entire screen of display or television to which the set to receiver is connected. The set top receiver will also provide additional zoom modes that are agnostic or independent of the aspect ratio of the display or television to which the set top receiver is connected. The set top receiver will then select the appropriate customized zoom mode automatically based on the aspect ratio of the display or television without requiring additional input from the user.

[0120] An exemplary embodiment of a method 240 for controlling the display of an image in a video signal being output to a display is shown in FIG 22. The set top receiver receives information as to an aspect ratio of the display to which the set-top receiver is

connected (step 241). The set top receiver then manipulates the received video image using a stretch/zoom technique to provide at least one customized zoom mode guaranteed to fill an entire screen of the display, as well as to provide one or more additional zoom modes that are independent of the aspect ratio of the display (step 242). The manipulated video image is output to the television or display using one or more ATSC formats (step 243). Input from a viewer is then used to select one of the at least one customized zoom mode or the one or more additional zoom modes (step 244). In the case of no input from the viewer, the zoom mode is set automatically based on the aspect ratio of the display without requiring additional input from the user (step 244).

Summary

[0121] The present invention includes exemplary embodiments implementing the ASTB Stretch Mode and the ASTB Zoom Mode features for the set-top boxes. Although various embodiments are specifically illustrated and described herein, it will be appreciated that modifications and variations of the invention are covered by the above teachings and are within the purview of the appended claims without departing from the spirit and intended scope of the invention. For example, certain aspect ratios are discussed, however, the present invention is applicable to other aspect ratios. Furthermore, this example should not be interpreted to limit the modifications and variations of the invention covered by the claims but is merely illustrative of possible variations.